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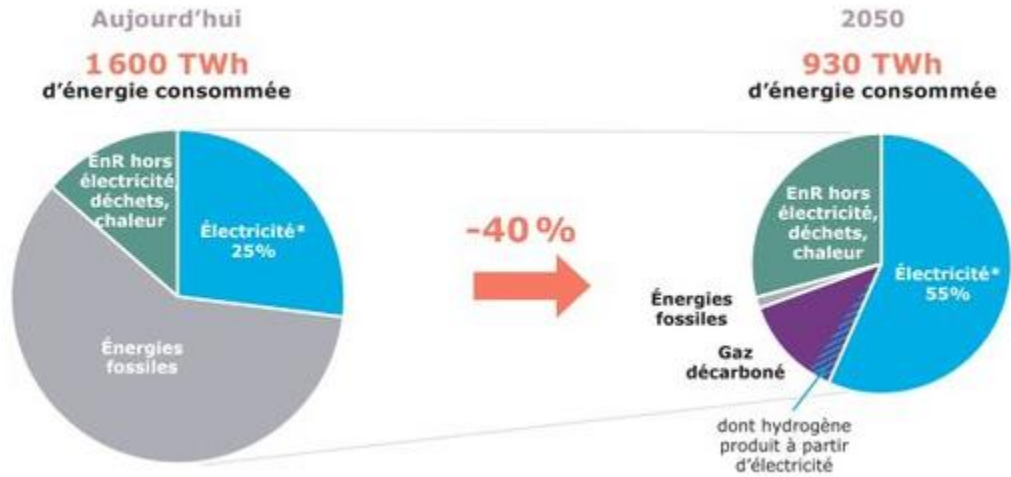
Symposium on **A**dvanced **T**echnologies
in
Electrical **S**ystems

Environmental impacts of different electricity production scenarios in France in 2060

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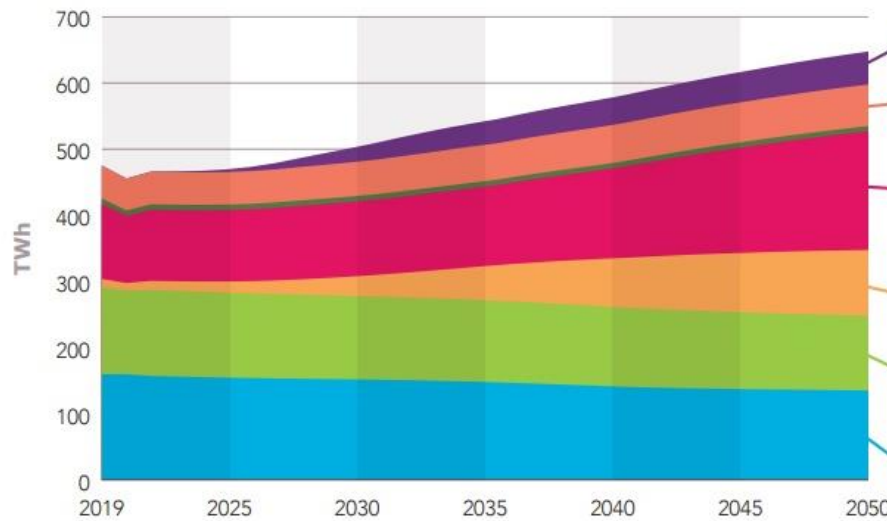


The future electricity consumption



National Low Carbon Strategy:
less energy but more electricity

Electricity :
France : +35%
Europe : +120%
Monde : +100%



Hydrogène (0 → 50 TWh) :
produit par électrolyse, pour les besoins industriels et le transport lourd

Énergie et pertes (50 → 60 TWh) :
légère croissance des pertes qui suit la demande d'électricité

Industrie (115 → 180 TWh) :
croissance de la production (valeur ajoutée +40% d'ici 2050) et électrification importante des procédés

Transports (15 → 100 TWh) :
fin des ventes des véhicules thermiques en 2040 : en 2050, 94% des véhicules légers et 21% de camions sont électriques

Tertiaire (130 → 110 TWh) :
croissance de la consommation des data centers (~x3), plus que compensée par l'amélioration de l'efficacité énergétique dans d'autres usages

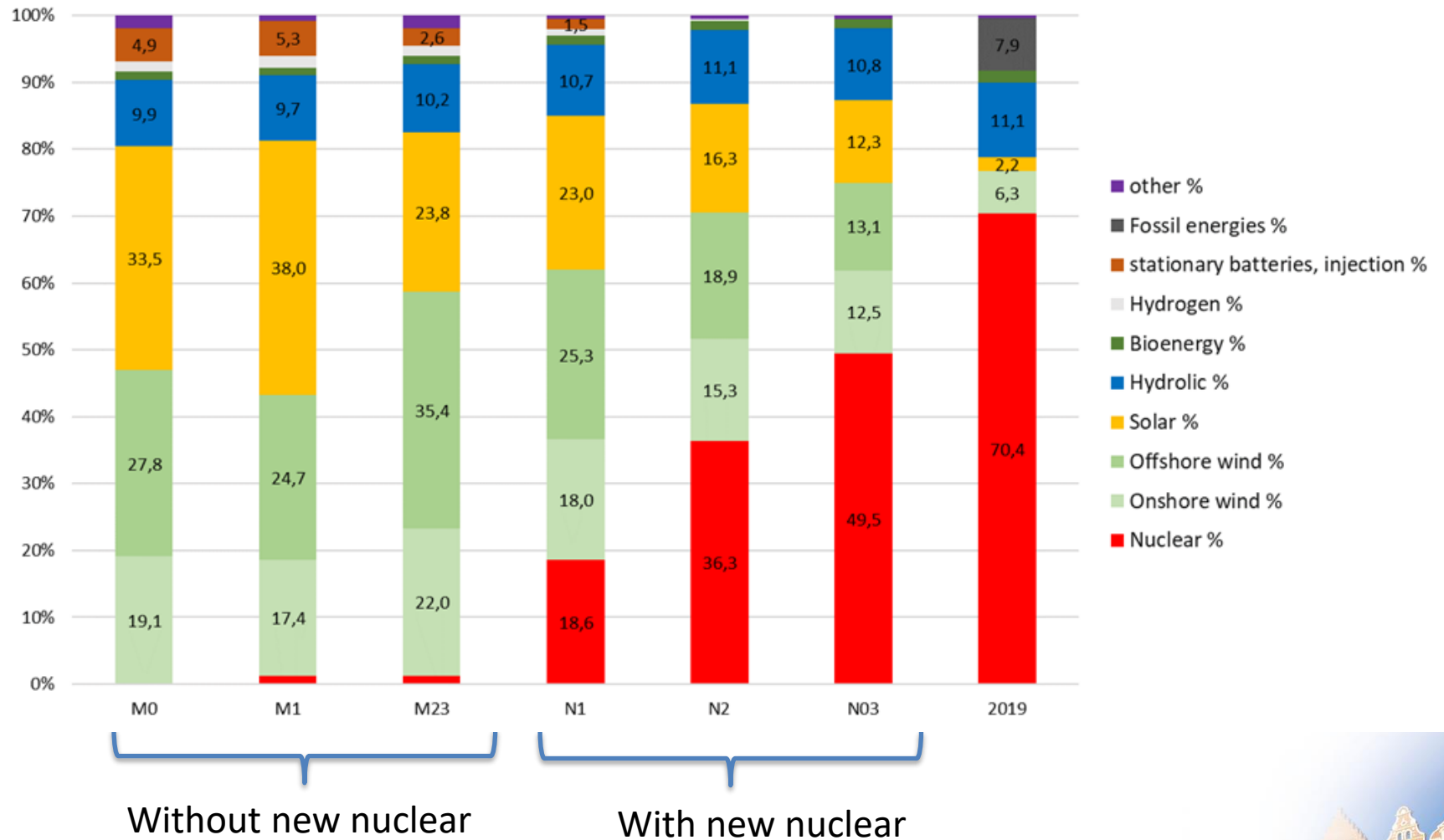
Résidentiel (160 → 135 TWh) :
le développement du chauffage électrique (70% en 2050 comparé à 40% aujourd'hui) est compensé par l'effet baissier des rénovations et l'amélioration de l'efficacité des équipements

■ Résidentiel ■ Tertiaire ■ Transports ■ Industrie
■ Agriculture ■ Branche énergie ■ Électrolyse

RTE scenarios : “Futurs énergétiques 2050” (2021)

How to produce electricity?

6 scenarios by RTE for 2060, in %

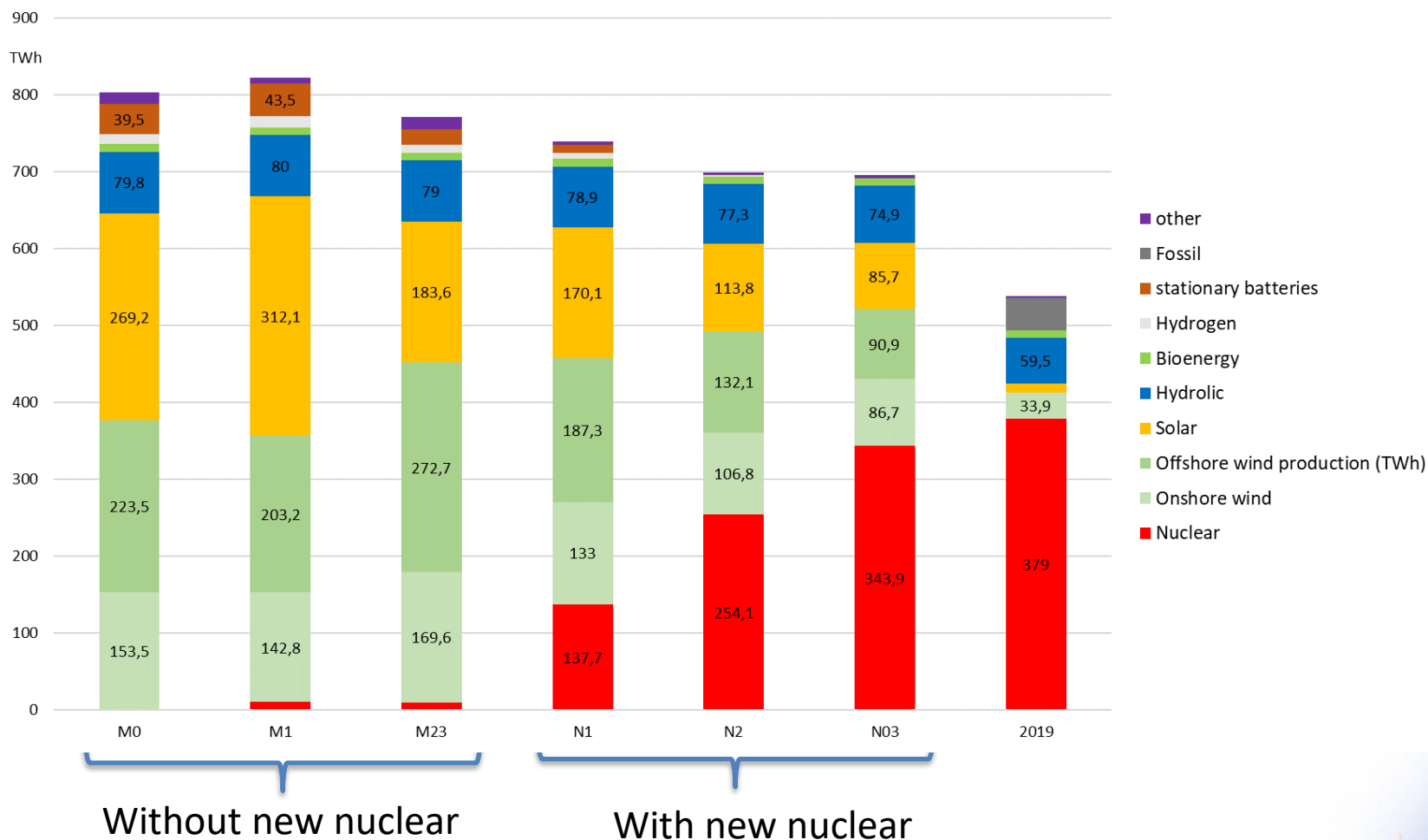


Nuclear : from 0 to 49,5%



RTE scenarios : “Futurs énergétiques 2050” (2021)

French electricity mix in 2060 in TWh

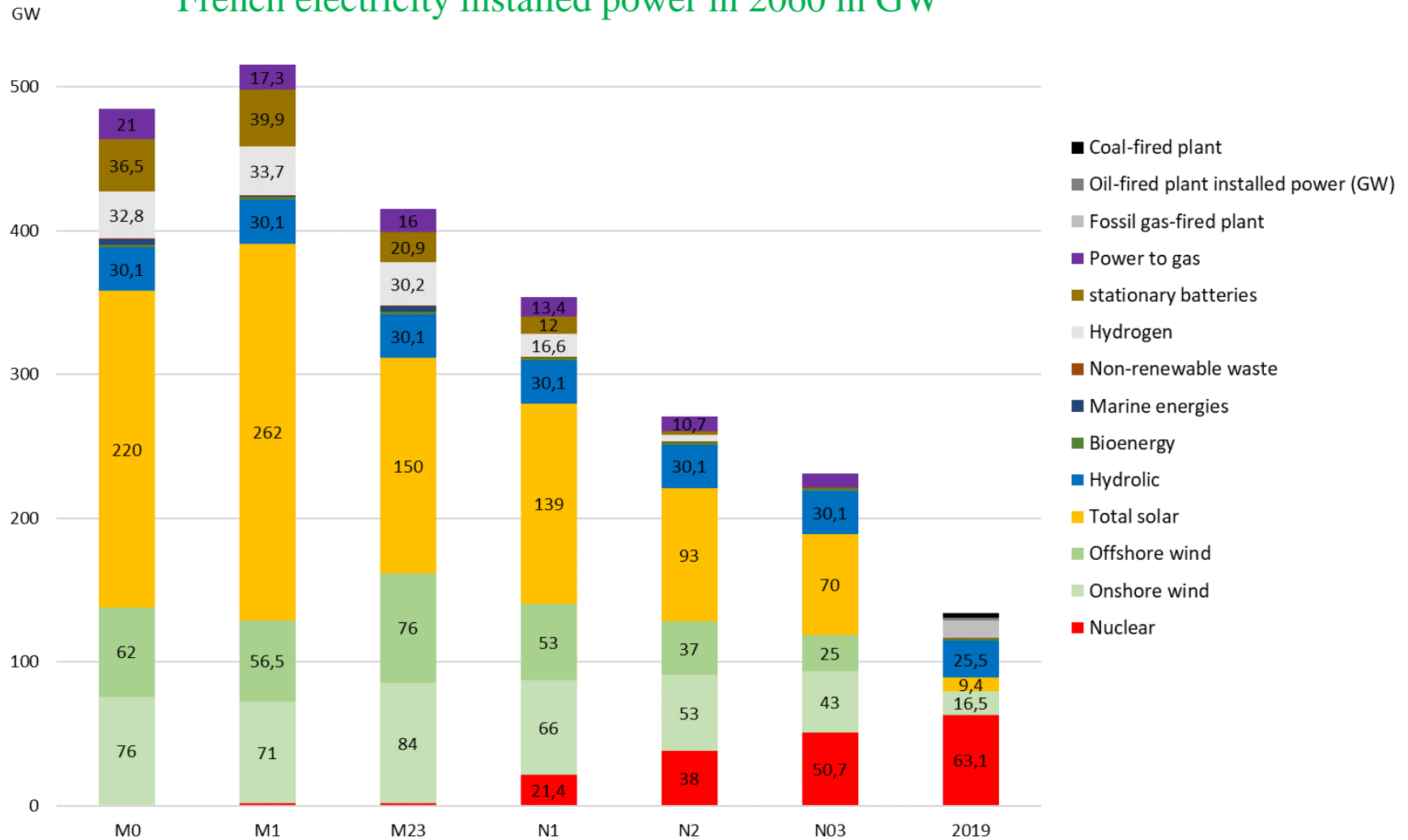


For the same consumption, production must be higher without nuclear power



RTE scenarios : “Futurs énergétiques 2050” (2021)

French electricity installed power in 2060 in GW



What about environmental impacts?



LIFE CYCLE ASSESSMENT

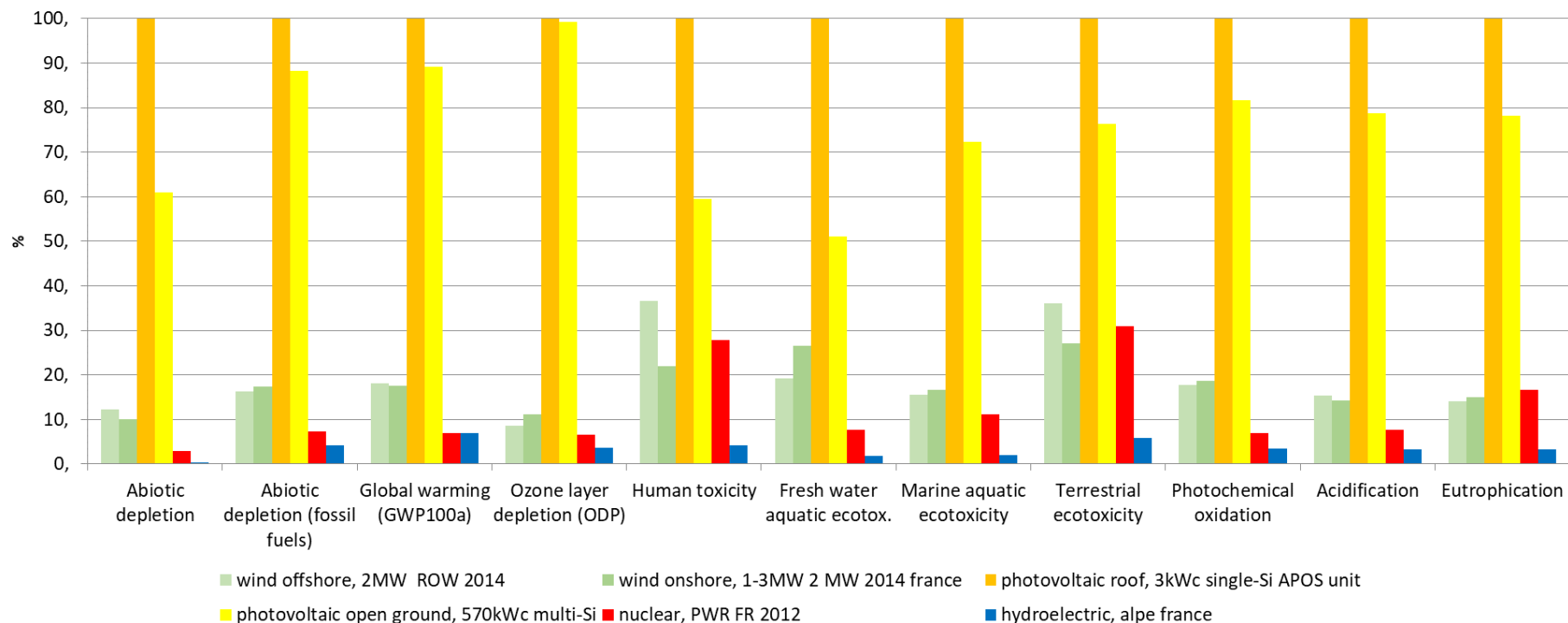
- Simparo software, Ecoinvent data base 2021
- Methods : “CML-IA baseline”, “allocation point of substitution” method
- 11 impact categories : abiotic depletion for minerals and fossil fuels, global warming, ozone layer depletion, human toxicity, aquatic ecotoxicity in fresh water and marine, terrestrial ecotoxicity, photochemical oxidation, acidification, eutrophication
- Select means of production in Ecoinvent (Wind turbine, 1-3MW, Photovoltaic roof 3kWp, Photovoltaic open ground, 570kWp, Nuclear, Pressure Water Reactor, France, Hydroelectric, alpine region, France...)
- 2 approaches
 - according to the production in Watt-hours. The software takes into account the known load factor and lifetime of the means of production,
 - according to the installed capacity in Watts. We have to take into account the lifetime of the means of production.

means of electrical production	nuclear	wind	photovoltaic	hydropower	bioenergies	marine energies	hydrogen to power	batteries
Life time (years)	60	25	30	80	30	80	30	20



Comparison according to the amount of energy produced

Environmental impacts of the means of production, 1MWh

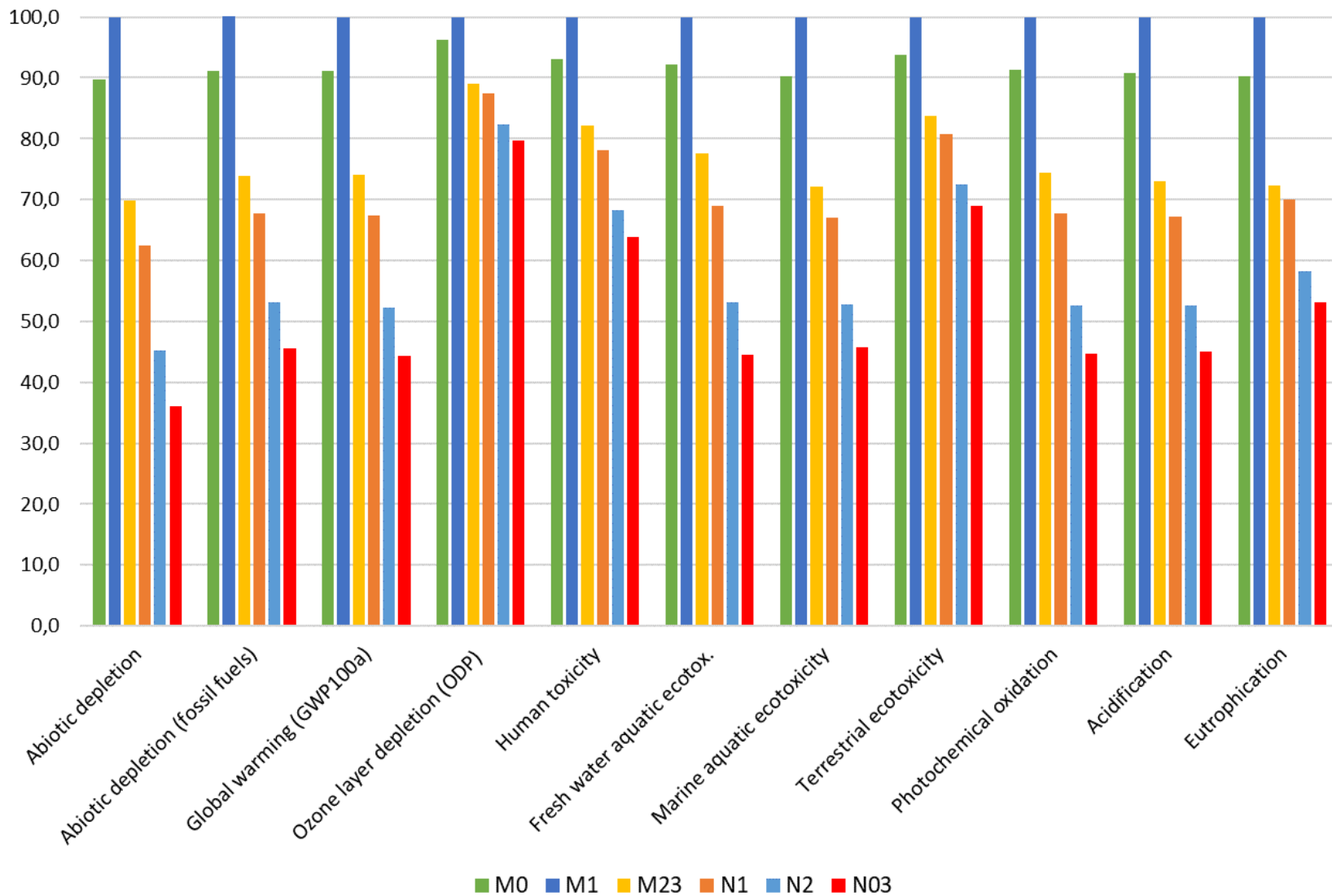


The manufacture of a photovoltaïque module requires more materials so its impacts are more important



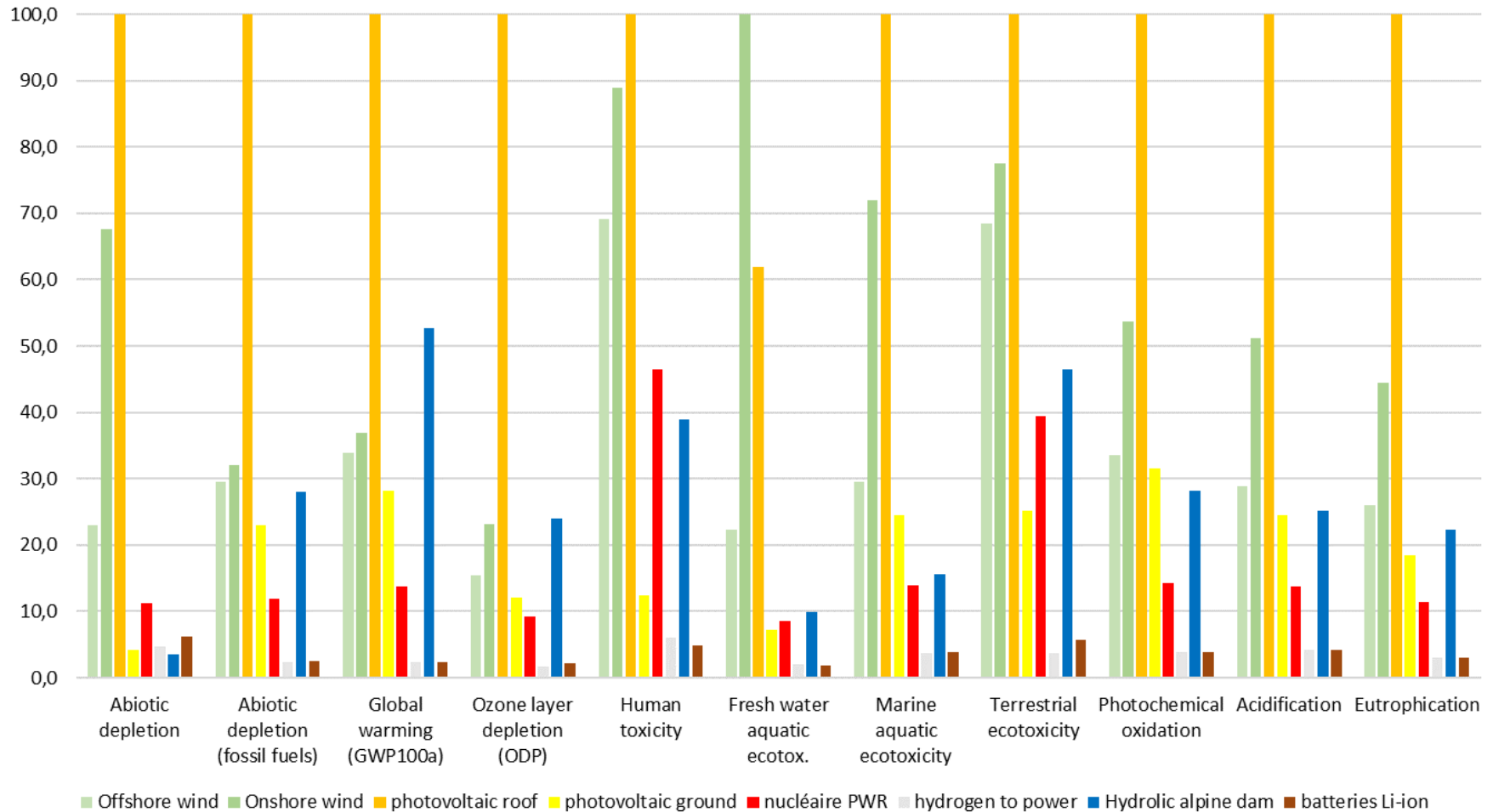
Comparison according to the amount of energy produced

Environmental impacts of the RTE scenarios



Comparison according to the installed capacity

Environmental impacts of means of production, 1GW infrastructure

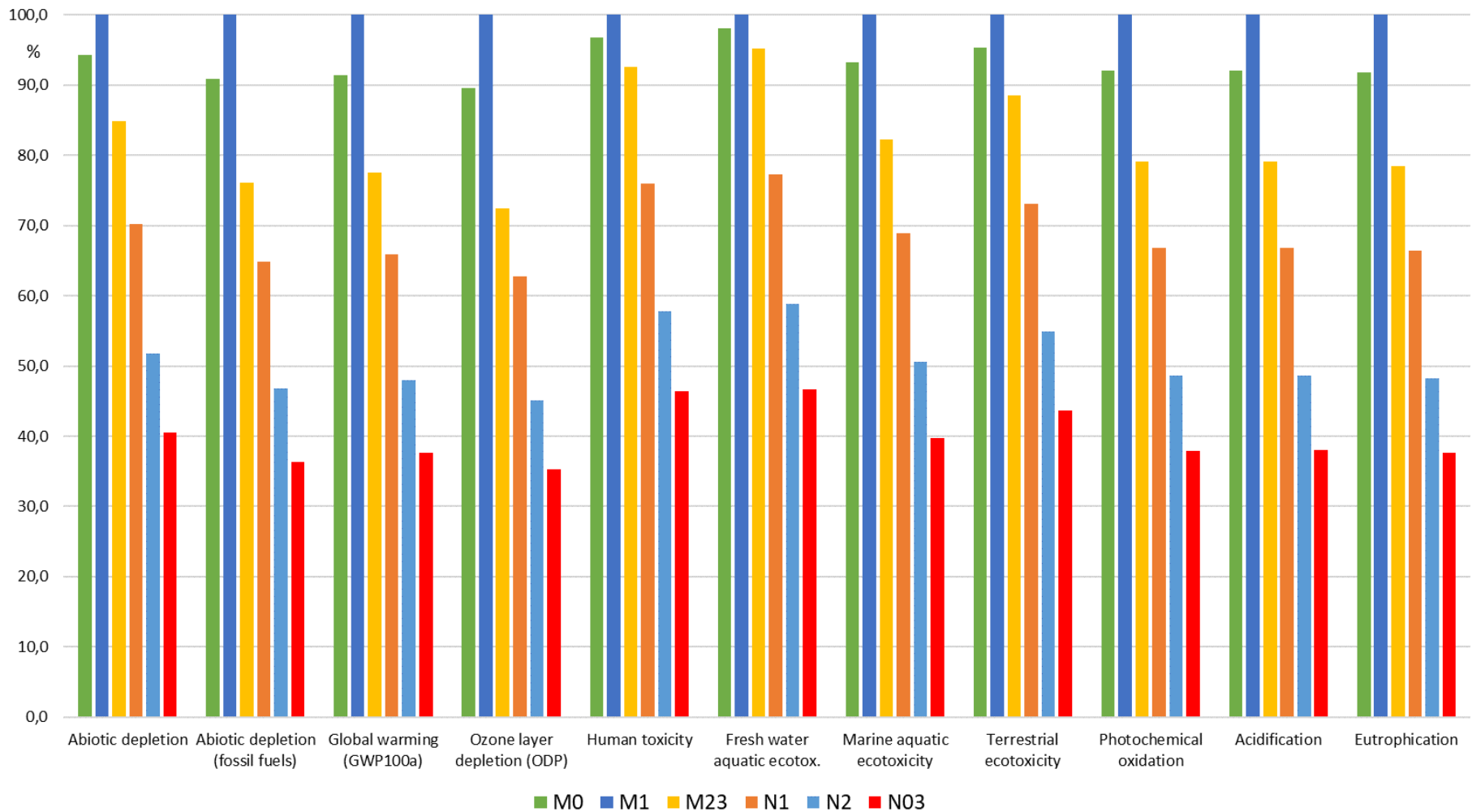


Wind power appears to be poor but less is needed because its load factor is higher



Comparison according to the installed capacity

Environmental impacts of the RTE scenarios



More nuclear power, less environmental impact
More photovoltaic, more impact



Conclusion

- The systems that require the most installed power have more impacts
- The scenarios with the highest use of photovoltaics are the worst
- Neglecting the risk of nuclear accidents and nuclear waste management, the scenarios that require nuclear power have less environmental impacts

